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14. ABSTRACT Autism spectrum disorders (ASDs) are disorders that affect as many 1 in 88 children. Without intensive treatment, the long-term outcomes for children with an ASD remain bleak and are associated with a high divorce rate among parents. Interventions based on applied behavior analysis are well documented, but unfortunately these services are often not available to military-dependent children because of the lack of appropriately training individuals. This project will demonstrate how web-based technologies can increase the availability of this effective treatment. The fifth year of the award involved the continued recruitment of families with a child with an ASD to evaluate the technology-enhanced early-intervention services in family's homes (Experiment 3). We have published results for the technology-enhanced tutor-training (Fisher, Luczynski, Hood, Lesser, Machado, & Piazza, 2014), which has now been cited by 13 studies (via Google Scholar). We have also obtained robust and statistically significant improvements in the technology-enhanced parent-training curriculum (Experiment 1), and we are preparing to submit this manuscript for publication. We recruited additional families to participate in the Experiment 3, and we plan to submit a subset of the outcomes (skills-based assessment) for publication.					
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Introduction

Autism spectrum disorders (ASDs) are disorders of the brain that affect as many as 1 in 68 children. Without intensive and appropriate treatment, the long-term outcomes for children with ASDs remain bleak and are associated with a high divorce rate among parents and increased risk for mental health disorders among family members. The efficacy of and empirical support for interventions for ASDs based on applied behavior analysis (ABA) is well documented. Unfortunately, these services are often not available to military-dependent children because there are not enough appropriately trained individuals to design and provide ABA services. This project will demonstrate how web-based technologies can increase the availability of effective treatment for children with ASDs. By evaluating a technology-enhanced treatment delivery model, families will be able to receive empirically supported treatment services in a timely manner anywhere in the world. Also, training therapists to implement ABA programs using a web-based model will greatly increase the number of well-trained therapists in areas around many military bases.

Body

Task 2. Complete parent and tutor training and EIBI aims for 5 cohorts, which includes 50 participant families and their ABA tutors (timeframe, Months 12-44).

From Statement of Work: *Tasks include three distinct sub-tasks for each cohort. Our training protocol based on E-Learning using the latest web-based and televideo-based instruction will provide an efficient and effective mechanism for training military parents of children with autism anywhere in the world by experts in one location (University of Nebraska Medical Center in Omaha). These trained parents will then be able to implement effective behavior management and teaching strategies with high procedural integrity (90% accuracy). Second, we will use the protocol we developed to train adults to become ABA tutors and to implement early intervention procedures with high integrity (90% accuracy) in areas of the world where such services are unavailable. The training protocol (using web-based E-Learning instructional methods) will be the same for the parents and the ABA tutors, but they will have more extensive curricula (with the curriculum for the ABA tutors being more comprehensive). Third, we will evaluate changes in cognitive, language, social, play, and adaptive skills and decreases in problem behaviors among children with autism in military families who receive technology-enhanced early intervention services that are supervised by our experts. The children in the technology-enhanced early intervention treatment group will show significantly greater improvements than children randomly assigned to a waitlist-control group.*

In each cohort, there will be 10 children with autism recruited with at least one parent (cohort $n \Rightarrow 10$) and one ABA tutor (cohort $n \Rightarrow 10$) per child. In the first cohort, 5 of the children and their corresponding parents ($n \Rightarrow 5$) and ABA tutors ($n \Rightarrow 5$) will be randomly assigned to the technology-enhanced early intervention treatment group and the other 5 children and their corresponding parents ($n \Rightarrow 5$) and ABA tutors ($n \Rightarrow 5$) will be assigned to the waitlist-control group.

We have reported progress for Experiments 1, 2, & 3 in this order.

Parent-training Evaluation (Experiment 1)

1. *Randomized Clinical Trial: Recruit, pretest, and train parents in the technology-enhanced test group and parents in the waitlist-control group.*

Efficacy Outcomes

- a. We now have pretest and posttest data for the randomized clinical trial with 11 parents assigned to the technology-enhanced group and 12 parents assigned to the waitlist-control group. The difference in the numbers across the groups is due to attrition. Attrition has occurred with nine parents (four and five assigned to the test and control groups, respectively), which has been due to unexpected changes in the parents' personal life that made it challenging for them to allocate the necessary time to complete the training.

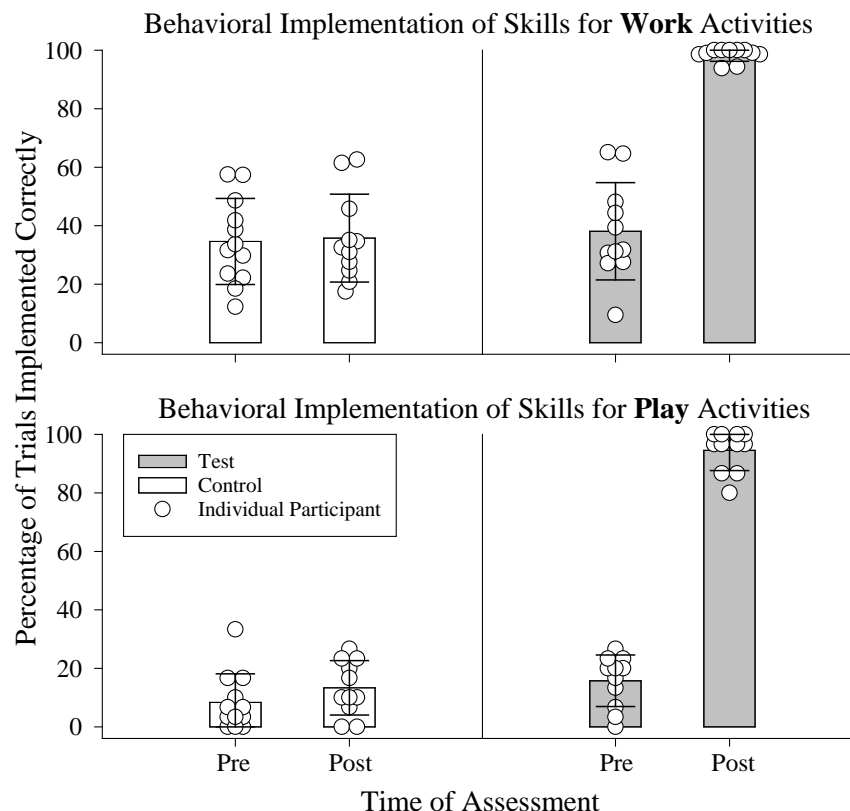
Two additional parents are enrolled; one parent is progressing through the technology-enhanced training while the other parent has been assigned to the waitlist-control group. We will continue to enroll parents as we enroll families for the early-intervention child training in Experiment 3. The outcome data for all the parents are depicted in Figures 1 and 2.

In Figure 1, the time of assessment is depicted on the x-axis. The top panel shows the parents' performance for the Behavioral Implementation Skills for Work Activities (BISWA) assessment and the bottom panel shows the parents' performance for the Behavioral Implementation Skills for Play Activities (BISPA). The mean performance of the parents assigned to the control group during the pretest and posttest are depicted on the left (white bar), and the mean performance of the parents assigned to the test group are depicted on the right (gray bar). The open circles denote the individual performance of each parent during each time of assessment.

The percentage of trials implemented correctly is depicted on the y-axis, and this measure was calculated by dividing the total number of trials implemented correctly plus the total number of errors, including both errors of commission (implementing a skill incorrectly; e.g., delivering reinforcement following an incorrect response) and errors of omission (failing to implement a skill when required; e.g., omitting descriptive praise following a correct response). This method of data analysis provided an overall measure of how accurately the tutors carried out the procedures, regardless of the unequal number of programmed opportunities across the trial types.

Prior to the technology-enhanced training (i.e., pretest), the parents' performance was unsatisfactory across both primary dependent measures and comparable across groups, with relatively worse performance observed in the BISPA (bottom panel). Following the technology-enhanced training, parents showed robust improvements in performance. All parents implemented the skills correctly on more than 80% of the trials on the BISWA and BISPA assessments (gray bar on posttest column), and there is no overlap with their performance in the pretest. By contrast, the performance of the parents in the control group showed no improvement (second white bar on the left).

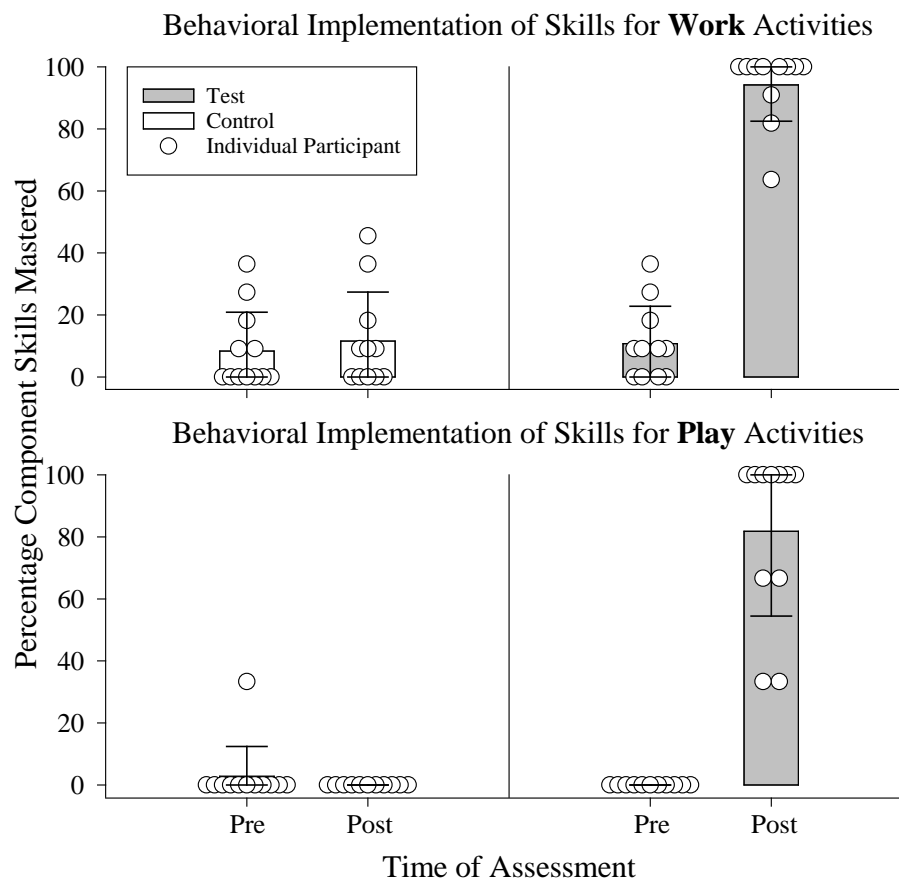
Figure 1.



In Figure 2, instead of reporting the percentage of trials implemented correctly on the y-axis, the percentage of skills mastered is depicted. This method of data analysis provided information on which specific skills the parents were implementing with high fidelity (i.e., mastery) and which skill should be targeted for booster training. In addition, this method controlled for differences in the number of programmed opportunities across trial types.

As observed in Figure 1, notable and robust differences were observed for the parents who received the technology-enhanced training for the BISWA (top panel) and BISPA (bottom panel), and no improvement was observed for the parents assigned to the waitlist-control group.

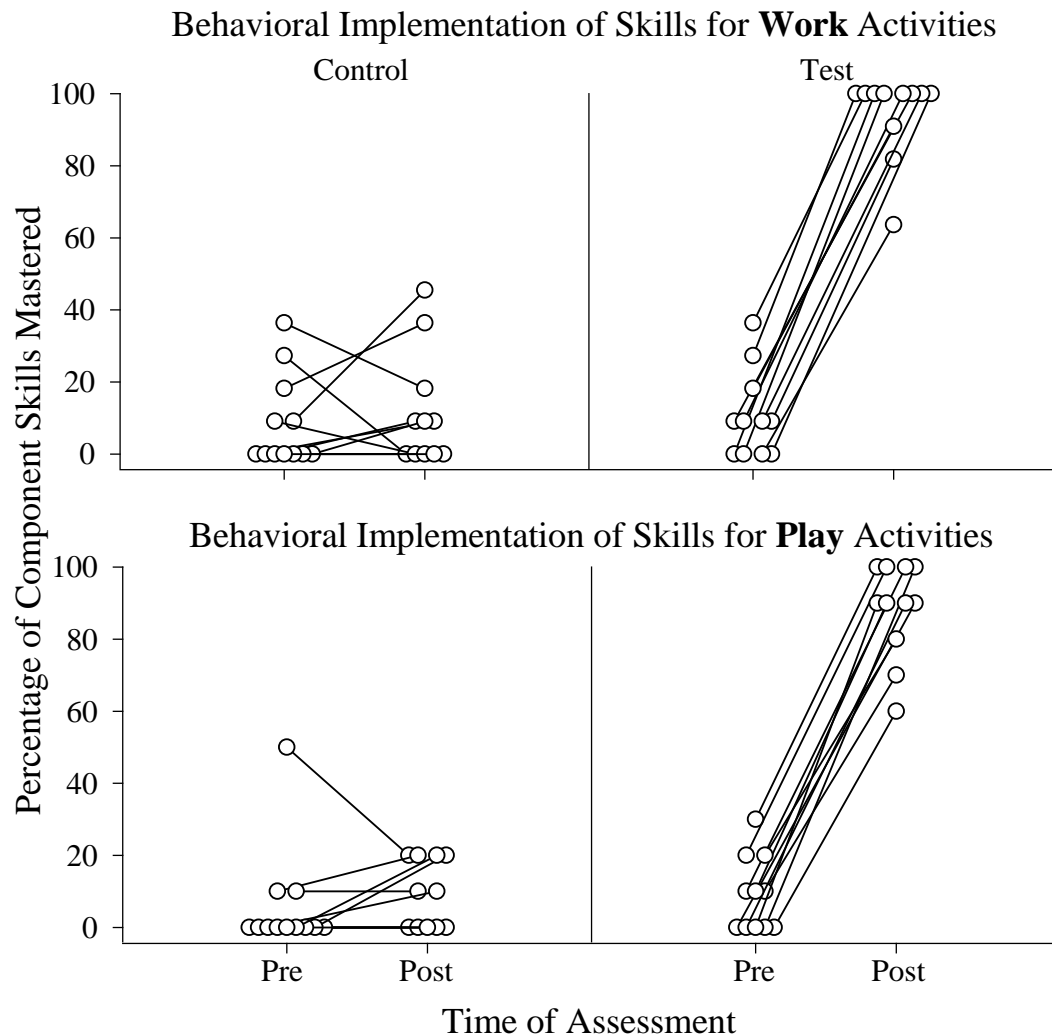
Figure 2.



- b. We also created an additional graphical analysis for the percentage of component skills mastered. We did this in order to observe the changes in performance from pretest to posttest at the level of each individual parent, which is obscured when aggregating the group data as done in Figures 1 and 2. The performance of the parents assigned to the control and test groups remained depicted on the left and right panel of Figure 3, respectively. However, instead of depicting the mean performance of parents during the pretest and posttest, we connected each parent's pretest and posttest performance using a line-and-scatter plot. For parents who received training, large improvements were

observed and their improvement was not dependent on their pretest performance (i.e., some parents who exhibited no mastered skills in the pretest showed mastery of all the skills in the posttest) for both the BISWA (top panel) and BISPA (bottom panel). By contrast, the performance of 10 of the 12 parents assigned to the control group showed minimal to no improvement or a worsening in performance. For the other two parents in the control group, there was a minor, unsatisfactory improvement from the pretest (9% and 18%, respectively) to posttest (43% and 38%, respectively).

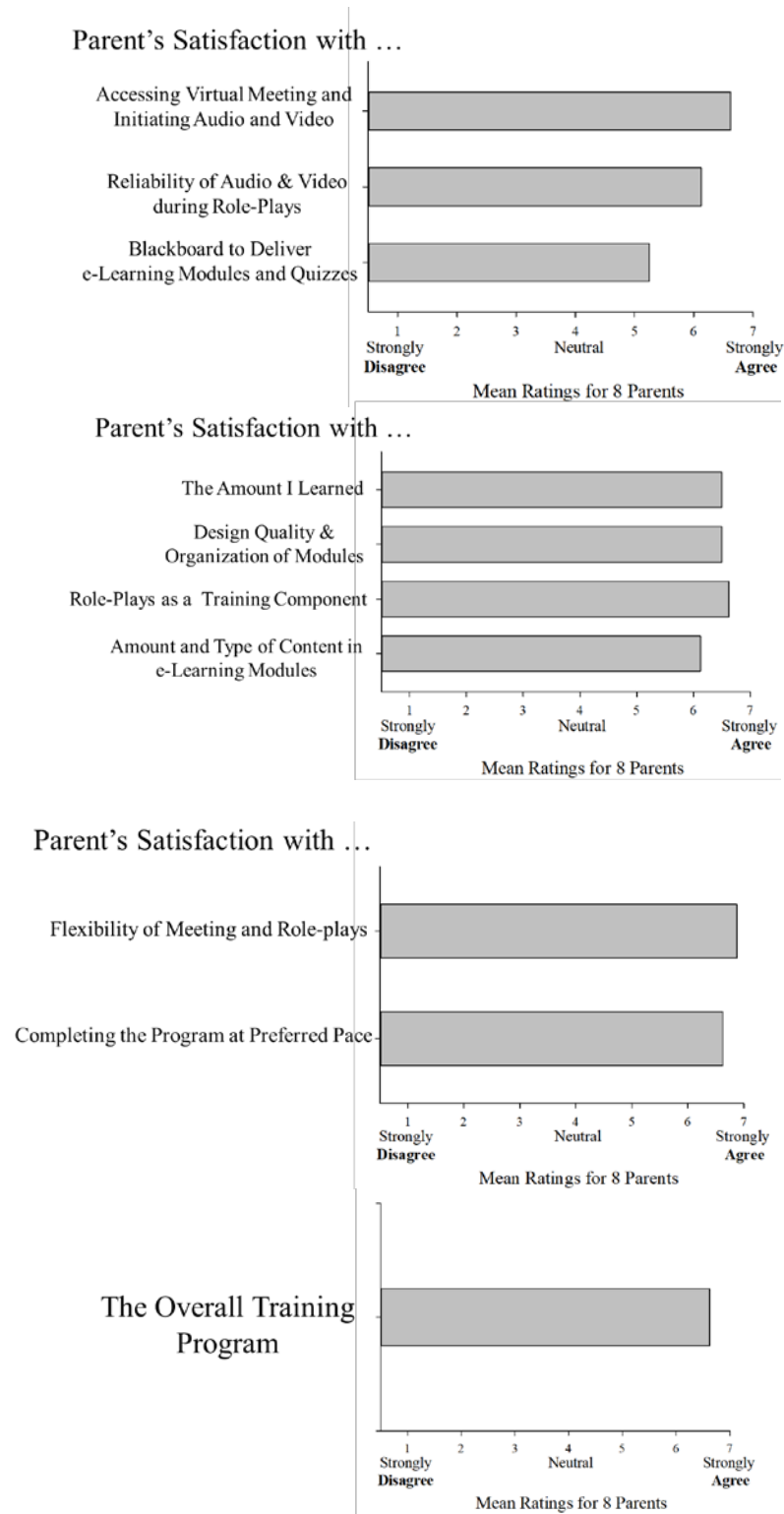
Figure 3.



Social-Validity Outcomes

- c. Following completion of the technology-enhanced parent training, we asked the parents to provide closed- and open-ended responses (ratings and comments) regarding their acceptability of the web-based technology, content covered during training, interactions with the consultant and scheduling, and overall impression of the training program. In Figure 4, we report the closed-ended ratings of the eight parents who completed the questionnaire; the parents used a 7-point Likert scale: 7 = strongly agree, 4 = no opinion, 1 = strongly disagree. All the parents reported high satisfaction with the training.

Figure 4.



- d. In the previous annual report, in addition to visual inspection of the outcomes we reported the results from a general linear model using the parents' performance on the pretest as a covariable. The difference between the treatment and control group means on the posttest was large (i.e., partial eta squared of .969, which is equivalent to a Cohen's d of 11.18) and statistically significant ($F = 216.15$; $p < .001$). Given the outcomes we obtained with additional parents, conclusions from the statistical results will remain the same. We will provide the reanalyses of the statistical tests in our final report.
- e. Dr. Luczynski presented the efficacy and social-validity data in an invited address at our field's annual national autism conference in New Orleans, Louisiana on January 20th, 2016. We are preparing to submit these data for publication to our field's applied flagship journal, *Journal of Applied Behavior Analysis*.
- f. We have also initiated a cross-continental evaluation with two Italian parents with a child diagnosed with autism who live in Italy, and we are using a multiple-baseline-across-subjects design to show experimental control over the effects of the technology-enhanced training. We plan to recruit a third parent. The training procedures are identical with those that we have applied to English-speaking parents except that we asked an Italian translator to participate. The translator provides bi-directional real-time translations during the pretests, posttests, and in-home training role plays. To date, we have obtained pretest data with both parents.

Tutor-training Evaluation (Experiment 2)

2. *Randomized Clinical Trial: Recruit, pretest, and train tutors in the technology-enhanced test group and tutors in the waitlist-control group.*

- a. Given that our primary focus at this point is producing outcome data on the effectiveness of our technology-enhanced early-intervention services for children with an ASD (Experiment 3), we are not enrolling additional tutors for this aim unless a tutor is needed to provide in-home services for a child in Experiment 3. We have data for an additional four tutors, which results in seven tutors assigned to the test group and nine tutors assigned to the control group. Attrition has occurred with nine tutors (six and three assigned to the test and control groups, respectively). We have no tutors currently completing the evaluation. The outcome data for 16 tutors are depicted in Figures 5 and 6 in same manner as described for Figures 1 and 2 above for the parent-training evaluation.

In Figure 5, prior to the technology-enhanced training, the tutors' performance was unsatisfactory across both primary dependent measures and comparable across groups, with relatively worse performance observed for the BISPA. Following the technology-enhanced training, the preliminary results with the tutors show robust improvements in performance. All tutors implemented the skills correctly on more than 80% of the trials on the BISWA and BISPA posttests; by contrast, the performance of the tutors in the control

group showed no improvement.

In Figure 5, instead of reporting the percentage of trials implemented correctly on the y-axis, the percentage of skills implemented correctly for each component skill is depicted. Robust differences were observed for the tutors who received the technology-enhanced training for the BISWA (top panel) and BISPA (bottom panel), and no improvement was observed for the tutors assigned to the waitlist-control group.

Figure 4.

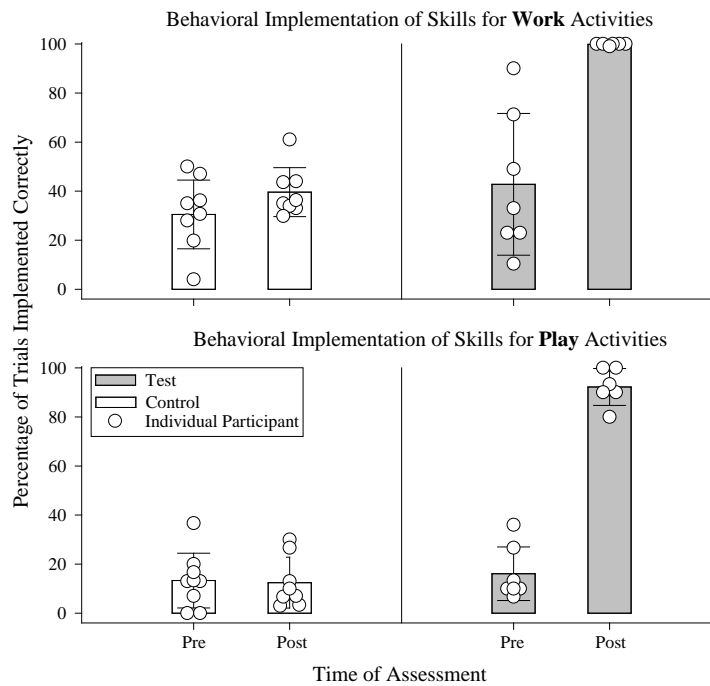
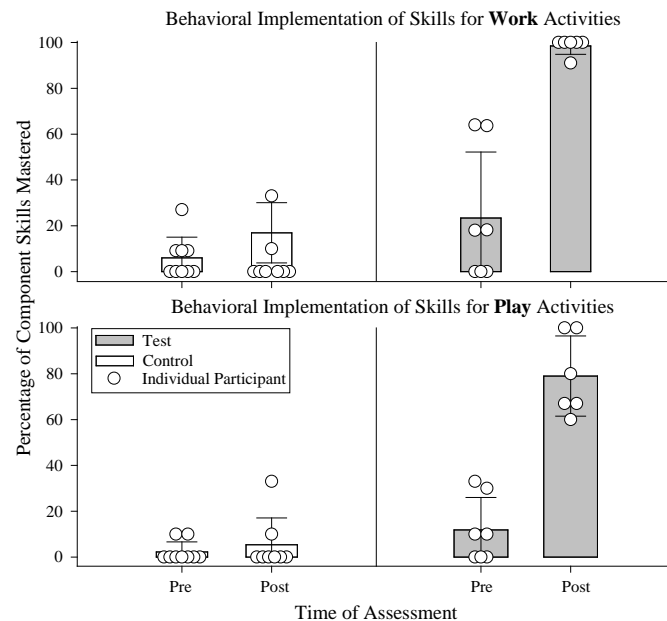


Figure 5.

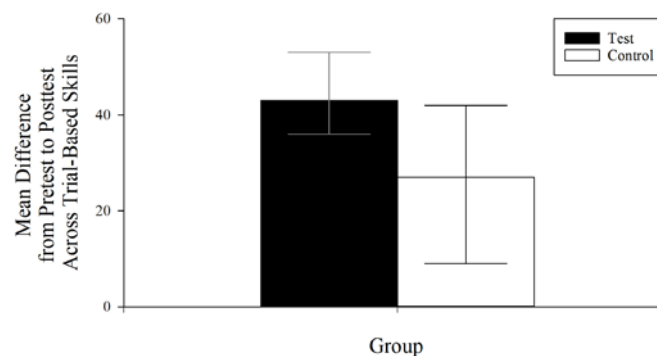


Child-Training Evaluation (Experiment 3)

3. *Recruit, pretest, and train and treat children in the technology-enhanced test group compared to children in the waitlist-control group.*
 - a. To date, 17 children have matriculated through the evaluation; 9 from the test group and 8 from the control group. Currently, we have only analyzed the performance of dyads for which both the test and control children completed the evaluation, which includes seven test-control dyads. In addition, we currently have one test-control dyad enrolled. Attrition has occurred for six children.
 - i. *Skills-based Dependent Measure:* The dependent measures for Experiment 3 include a battery of standardized assessments, including the Peabody Picture Vocabulary Test, Expressive Vocabulary Test, and Mullen Scale of Early Learning. In addition to these standardized assessments, we designed a competency-based assessment that sampled skill domains for early learners called the *Autism Curriculum Based Assessment*. The skills we included was informed by the domains tested in the Assessment of Basic Language and Learning Abilities, which is a common assessment in the early-intervention literature that qualitatively and quantitatively defines a child's skill level that guides intervention development.

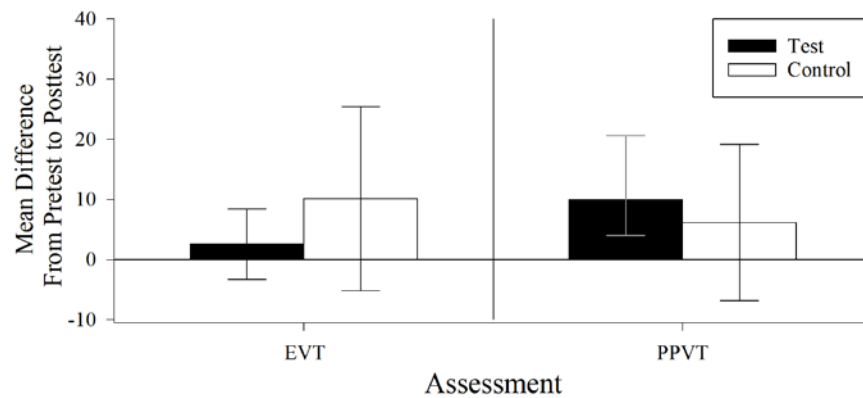
The mean difference from pretest to posttest across all the skill areas in our skills-based assessment between children assigned to each group is depicted in Figure 6. For the children assigned to technology-enhanced training (black bar), a 34% increase was obtained, which was greater than 18% increase obtained with the children assigned to the waitlist-control group (white bar), which was 18%. The gray line for each bar denotes the standard deviation. We also conducted a Wilcoxon Signed-Rank Test, which indicated that posttest ranks for the test group were significantly higher than the control group, $Z = 3.53$; $p < .001$. The results provide support for the efficacy of our web-based program to provide in-home early-intervention services to families. We plan to submit the outcomes for this skills-based dependent measure (*Autism Curriculum Based Assessment*) for publication.

Figure 6.



- ii. *Standardized Dependent Measures:* The results for the Expressive Vocabulary Test (EVT; left panel) and Peabody Picture Vocabulary Test (PPVT; right panel) are reported in Figure 7. The type of assessment is depicted on the x-axis; the mean difference from pretest to posttest is reported on the y-axis. The black and white bars denote the mean performance for the children in the test and control groups, respectively; the line for each bar denotes the standard deviation. We have not observed robust differences between the children assigned to the test and control groups for the EVT and PPVT measures.

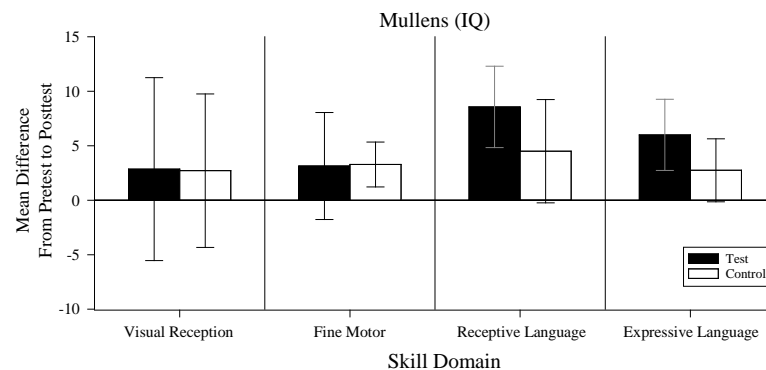
Figure 7.



The results for the Mullens Scale of Early Learning are reported in Figure 8. The domains in the assessment are denoted across the four phases, and pretest and posttest measures are reported in each phase. As in Figure 7, the black and white bars denote the mean of participants' performance in the test and control groups, respectively. Visual inspection of the figure involves looking for relative increases in the height of the mean from pretest to posttest.

An improvement from pretest to posttest for children assigned to the test group was observed for receptive language and expressive language. However, the degree of improvement does not notably exceed that observed for the children assigned to the waitlist-control group.

Figure 8.



Key Research Accomplishments

- Technology-enhanced Parent-training Curricula (Experiment 1): We now have pretest and posttest data for the randomized clinical trial with 11 parents randomized to the technology-enhanced group and 12 parents randomized to the waitlist-control group. Our outcomes provide convincing evidence of the efficacy of our telehealth training with parents in the convenience of their home. Moreover, our social-validity ratings show that all the parents reported high satisfaction with nearly all features of the technology-enhanced training. To date, we have presented these results at our field's annual national conference (Chicago, 2015) and our field's annual national autism conference (New Orleans, 2016). We are preparing to submit these data for publication to our field's applied flagship journal, *Journal of Applied Behavior Analysis*.
- Technology-enhanced Tutor-training Curricula: We have reported data for an additional four tutors, which results in seven tutors assigned to the test group and nine tutors assigned to the control group. The outcomes for these tutors replicate the findings we published in 2014 (Fisher, Luczynski, Hood, Lesser, Machado, & Pizza, 2014). Given that our primary focus at this point is producing outcome data on the effectiveness of our technology-enhanced in-home services for children with an ASD (Experiment 3), we are not enrolling additional tutors for this aim unless a tutor is needed to provide in-home services for a child in Experiment 3.
- Technology-enhanced Early-intervention Services: Seventeen children – with includes seven complete test-control dyads – have completed the evaluation. The outcomes provide support for the efficacy of our web-based program for the skills-based dependent measure (*Autism Curriculum Based Assessment*). We conducted a Wilcoxon Signed-Rank Test, which indicated that posttest ranks for the test group were significantly higher than the control group, $Z = 3.53$; $p < .001$. We plan to submit this subset of outcomes for publication.

Reportable Outcomes

- We presented the randomized clinical trial for the technology-enhanced parent-training curriculum (Experiment 1) at our field's national autism conference in January, 2016 (Association for Behavior Analysis International – Autism).
- We are preparing the outcomes from the technology-enhanced parent-training (Experiment 1) for publication in our field's flagship journal.
- We are preparing a subset of the outcomes – data from the skills-based assessment – from the technology-enhanced child training (Experiment 3) for publication.

Conclusions

The procedures of the technology-enhanced parent training (Experiment 1) and tutor training (Experiment 2) have reliably produced robust outcomes. A proportion of the outcomes from Experiment 2 have been published in a peer-reviewed journal (Fisher, Luczynski, Hood, Lesser, Machado, & Pizza, 2014; 13 peer-reviewed citations). We are preparing the manuscript for Experiment 1, and we expect that the manuscript will be published. The results of technology-enhanced child training (Experiment 3) show improvement on the skills-based assessment; however, similar improvements have not been captured for the standardized dependent measures.

References

Luczynski, K. C. (2016, January 20th honorarium). *Preliminary Findings in a Randomized Clinical Trial of a Virtual Training Program for Parents of a Child with Autism*. Invited address presented at the 10th Autism Convention of the Association for Behavior Analysis International, New Orleans, Louisiana.